The Journal of the Parliamentary and Scientific Committee

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SPRING 2018

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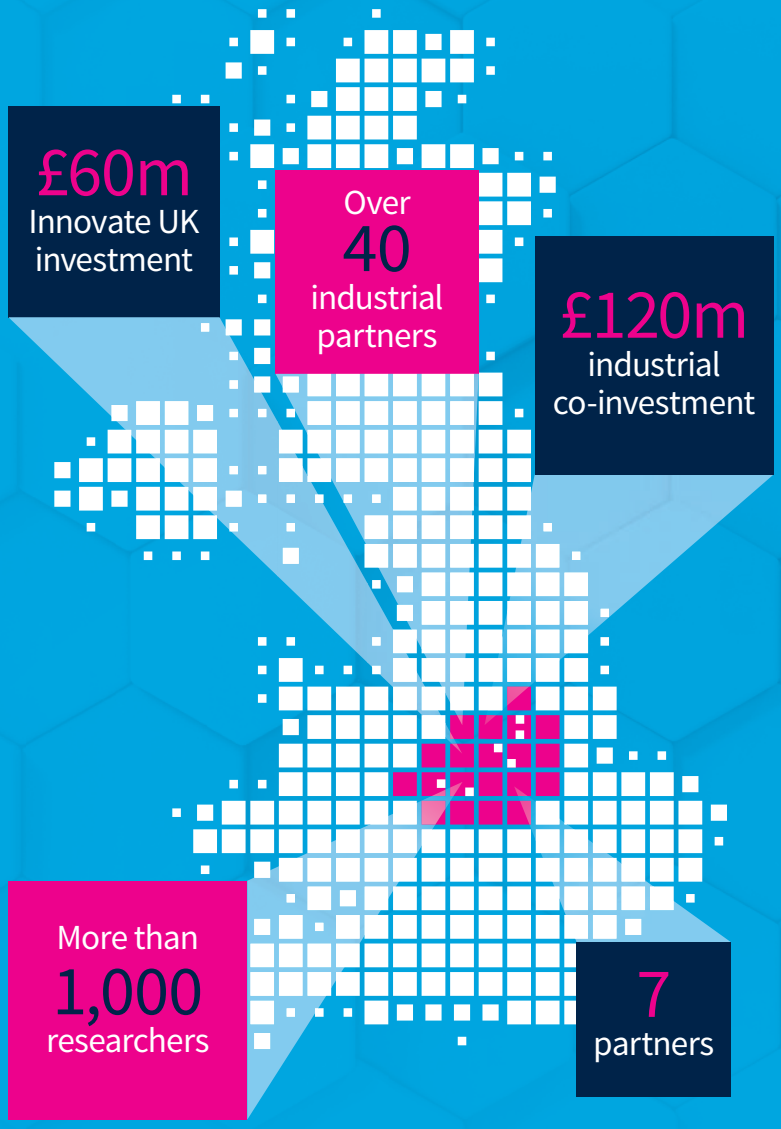

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Stephen Metcalfe MP, Chairman, Parliamentary and Scientific Committee

Welcome to the Spring edition of *Science in Parliament*. As ever it has been a busy start to the year for both myself and the Parliamentary and Scientific Committee. Our opening meeting on *'Data as a resource'* drew a capacity audience fascinated in the potential of data but also concerned about some of the ethical issues presented. Many of the issues presented by our excellent speakers are included in this edition. We also include a summary of the meeting we held jointly with the APPG on Food and Drink Manufacturing where we discussed the Science of Food Manufacturing.

As the Government Envoy to the Year of Engineering – the campaign that will see government join forces with industry to give thousands of young people direct and inspiring experiences of engineering throughout 2018 – I have been busy around the country visiting projects. You can discover more about the Year of Engineering in this edition and find out more about how you can get involved in this celebration of Engineering.

I was pleased to see many fascinating engineering projects alongside those from the biosciences, physical sciences and mathematics at the finals of our Annual Poster Competition STEM for BRITAIN. Details of the winners can be found on the website www.stemforbritain.org.uk and we will be publishing a special STEM for BRITAIN edition of *Science in Parliament* in the Summer.

I hope you will enjoy the plethora of other topics presented in this issue from the up and coming science surrounding microbiomes both within and around us to how science and engineering can help us with the real challenge of achieving the ambitious CO_2 reduction targets set by Government of 50% compared with 1990s levels by 2030, and an 80% reduction by 2050.

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The Journal of the Parliamentary and Scientific Committee.
The Parliamentary and Scientific Committee is an All-Party Parliamentary Group of members of both Houses of Parliament and British members of the European Parliament, representatives of scientific and technical institutions, industrial organisations and universities.

Science in Parliament has two main objectives:
1. to inform the scientific and industrial communities of activities within Parliament of a scientific nature and of the progress of relevant legislation;
2. to keep Members of Parliament abreast of scientific affairs.

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ENERGY EFFICIENT MOTORS ON AN INDUSTRIAL SCALE

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Innovative energy efficient electric motor technologies can significantly reduce industrial electricity demand on a global scale, saving process-intensive industries money while helping to combat climate change.

It is worth starting with the fact that total energy consumption of the entire globe is approximately more than 100,000 TWh, which is the amount of energy that has undergone processing from primary forms into usable forms (electricity, heat, etc. at the point of use). The total production is higher (around 20%) due to losses in the transformation processes and its transportation from its initial place of supply to the domestic and industrial consumers. The amount of energy produced is a vast amount by any standard and has been increasing annually (e.g., in 1975 the consumption was approximately half of what it is now) and thus the production of useful energy, its supply, and efficient end-use is a global *grand challenge*. This challenge is not only technical in nature, but there are also significant economic and political issues to be tackled. It is of a global nature, and it is multi-faceted. It requires input from not only academia, relevant industries, the financial sector, and trade organizations, but also policymakers – there are many stakeholders, including the public. Of course, there is no easy solution, and it will be a long road to securing a sustainable and economically viable energy infrastructure for the future. One way to assist this endeavor is to generate an increasing amount of useful energy using renewables, or else reduce the demand, perhaps by increasing energy efficiency?

Concerning the UK and Europe, the *Energy Efficiency Financial Institutions Group* (EEFIG) suggests that there is a vast potential for energy savings (energy efficiency) in both buildings and industry[1]. Energy efficiency can mean reducing overall energy demand. This can be achieved by increasing supply security through reduced reliance on imported energy (presently around €400bn per year), enhancing the competitiveness of UK & EU industry, as well as acting to address, somewhat, the global environmental challenges. Action must follow to meet the demanding targets for 2020, 2030 and beyond, as agreed by world legislators. Global energy efficiency drives are explicitly backed up by various international governmental agreements, for example, the Paris Agreement and more specifically from the European Commission, where on 30th November 2016 the Commission proposed an update to its *Energy Efficiency Directive,* including a new 30% energy efficiency target for 2030[2]. So, there is some traction here.

However, here we are primarily concerned with electrical energy. Global electricity consumption is approximately 21.36 trillion kWh (a CIA Fact Book estimate from 2014[3]), which is the equivalent of over 2 billion 1kW kettles boiling away, 24 hours a day, 365 days per year – a tremendous amount of Earl Grey to be consumed, one might say. It is interesting to note the fact that over 45% of the global electricity energy demand is utilized by electric motor systems; according to various reports such as the Department for Business Innovation & Skills[4], the International Energy Agency[5] and Global Industry Analysts. Inc[6]. The analysis of which was taken on board by, and significantly influenced, a recent report entitled "Technological Feasibility Studies for Super- and Ultra-Premium Efficient Motors" by an international working

group the International Council on Large Electric Systems (CIGRE)[7]. This report goes on to claim that improving the energy conversion efficiency of industrial electric motors by 3% (which is possible with technology currently available), yields the potential to save over 350TWh (>100 nuclear power plants, each rated at 1GW) of annual electricity demand. A staggering sum equating to a Carbon Dioxide Equivalent ($C0_2E$) of approximately 260 million metric tonnes, based on the United States Environmental Protection Agency methods.

The scale of the potential savings is not surprising, perhaps, when we consider the scale of industrial and manufacturing activity in the UK and Europe at large. In the heavily industrialized regions (e.g. the US and China *et al*.), where just about all industrial processes involve some form of rotary motion: this is where the "electric motor" converting electrical power into rotary mechanical power is deployed. Applications such as fans/blowers, mills, pumps and conveyor belts on production lines, to name but a few, are commonplace and typically operate 24 hours per day, 365 days per year at thousands of geographical locations, with each of those locations (factories) containing hundreds/thousands of electric motors. The annual sales volume for electric motors is in the billions. Not limited to the UK, or even Europe and the USA – the scope of the energy efficiency improvements amongst industrial motor drive systems encompasses every industrialized nation.

Therefore, it is clear from these studies that improvements in industrial electric motor efficiency represent a significant opportunity to reduce global energy demand and industrial operating expenditure on electricity. Of course, this is inherently complemented by a fall in greenhouse-gas emissions, as above – which in turn will allow us to halt, or at least slow down the rate of rise of the surface temperature of the Earth considering the +2°C target.

Concerning the UK, some government work has already identified this. Most recently, the Department for Business, Energy & Industrial Strategy's Digest of United Kingdom Energy Statistics report in 2016[8] stated 26% of UK electricity use is in 'industry', consuming 92GWh – the second largest consumer – showing that this is a significant energy vector in the UK. An earlier Department for Business, Innovation & Skills report from 2011 states[4]:

"Industrial electric motors account for more than 60% of all [UK] electrical energy consumption."

This statement covers consumer goods (spinning microwaves and washing machines, etc.) – it also suggests that like the EU and CIGRE *et al*., that there is a vast room for improvement in energy efficiency in this arena with great benefits to be realized, *if*, energy efficiency gains can readily be obtained. This same conclusion is identified in the 2012 Department of Energy & Climate Change independent report *"Capturing the full electricity efficiency potential of the U.K."* compiled by McKinsey & Co to accompany the "Electricity Demand Reduction: Consultation" on options to encourage permanent reductions in electricity consumption[9]. These studies published by significant international institutions in the UK, the EU and beyond constitute a compelling case for action on policy in this area.

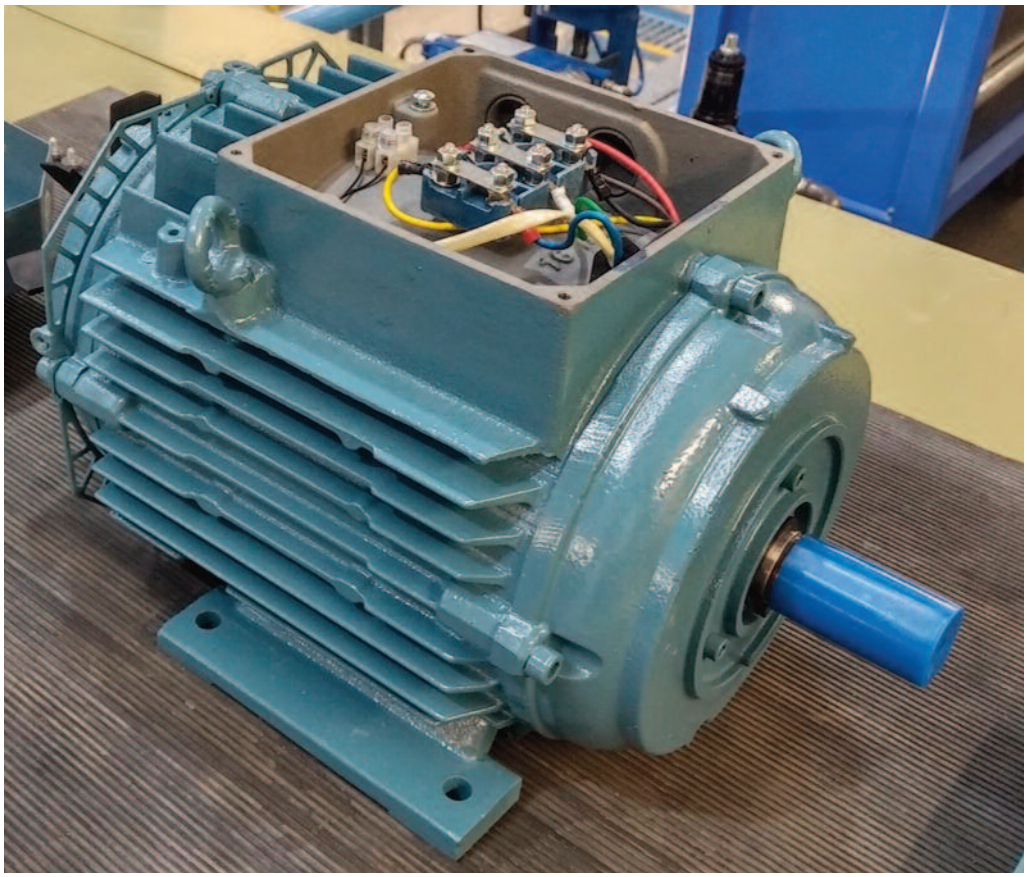
Following the recent referendum vote for Brexit, the Durham Energy Institute at Durham University (which has expertise in the technological challenges associated with increased efficiency of industrial motor drive systems), submitted

evidence[10] to the House of Lords' EU Energy and Environment Sub-Committee report on Brexit: Energy Security[11]. The evidence stated;

"The UK government should, post-Brexit, incorporate an ambitious energy efficiency and energy demand reduction directives in to UK policy framework, particularly in heavy industry with an emphasis on higher efficiency electric motors. The UK should seek to match or exceed the EU legislation (existing and future) on this matter to ensure security of supply by reducing demand through the adoption of new and appropriate technology."

With this, the industrial electric motor drive system market represents an area of opportunity for the UK in Energy Efficiency policy; it deserves further consideration and research regarding policy frameworks and technological advancement in order to realize our long-term energy efficiency targets, assist with energy security and sustainability, and contribute to combating climate change.

The technical question is "How do we obtain the energy efficiency increase?" The motor technology selection is of importance here but does not answer all the follow-up questions as one technical solution does not suit all – again, there is no simple answer. That said, the solution is to be found by considering a range of engineering options such as new and improved materials and manufacturing techniques utilized in motor construction, improved motor designs and choice of inherently more efficient motor technologies. The framework of possibilities is outlined in the CIGRE technical feasibility report[7] which concludes that the 3% energy efficiency increase is possible in accelerated time frames (2020 onwards). This conclusion is backed up by the author's work and recent analysis[12] of a new type of motor technology to replace the traditional 'induction motor'. It is true to say that modern manufacturing and process intensive industries are underpinned by Victorian technology. An innovative technology, well placed to replace this Victorian infrastructure is called 'Synchronous Reluctance', the technical details are omitted here, but it suffices to say that an efficiency improvement of 2-4% (each motor) can be readily obtained by its adoption. Hence, we must encourage motor manufacturers, governments, academia and broader industry to engage in an international response to climate change by tackling the energy efficiency of industrial electric motor drive systems. The response must encompass innovative energy efficient electric motor technologies coupled with a relevant policy framework to encourage the necessary engineering research and development, both in industry and academia, and the adoption of new energy efficient technology by traditionally conservative industries. This innovation could save process-intensive industries money while reducing energy demand and assisting in combating climate change and improving energy security.



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